PERFORMANCE OF STONE MASTIC ASPHALT INCORPORATING STEEL FIBER.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Batu Mastic Asfalt (SMA) adalah jurang campuran campuran gred panas yang mengandungi peratusan besar agregat dan pengisi bitumen mastic. Biasanya campuran SMA telah ditambah dengan pengikat polimer yang diubah suai. SMA menderita pengaliran parah yang teruk akibat jurang campuran agregat yang bergred yang cenderung memberikan batu yang stabil ke batu batu termasuk campuran kaya mastic asfalt. Serat Keluli adalah bahan tambah yang akan menstabilkan mortar asfalt dan menebalkan bitumen untuk mengelakkan pengikat berlebihan. SMA baik untuk digunakan dengan kehadiran serat untuk meningkatkan ketahanan campuran SMA. Oleh itu, kertas ini membentangkan keberkesanan menggunakan gentian keluli dalam meningkatkan daya tahan di lapisan permukaan turapan SMAadalah lapisan yang secara langsung terdedah kepada kesan lalu lintas. Untuk membuat campuran SMA, spesimen dipadatkan dengan menggunakan 50 pukulan pada setiap muka menggunakan pemadat Marshall pada suhu pemadatan tertentu. Kemudian, spesimen yang telah diubah suai telah diuji untuk menilai prestasi dari segi ujian Los Angeles Abrasion, Ujian Kestabilan Marshall, Ujian resilient Modulus dan Dynamic Creep. Keputusan menunjukkan bahawa spesimen yang mengandungi gentian keluli boleh digunakan dalam kursus pengikat jalan kaki yang fleksibel kerana kesan kestabilan yang positif. Hasilnya menunjukkan bahawa penambahan gentian 0.3% membawa kepada kestabilan dan kekukuhan yang lebih baik sementara, penambahan gantian 0.5% untuk dinamik modulus berdaya tahan meningkat pada 25 ℃ dan penambahan 0.4% pada 40 ℃. Kesimpulannya, penambahan serat keluli dalam campuran mempunyai potensi untuk memperbaiki masalah pengikat. menjana campuran turapan yang lebih baik, disarankan untuk membuat kajian lanjut pada masa akan dating menggunakan serat pada suhu yang dipadatkan dan jumlah pukulan yang berlainan.

ABSTRACT

Stone Mastic Asphalt (SMA) is a gap graded hot mix asphalt that contains a large percentage of course aggregate and bitumen filler mastic. Usually, SMA mixes has been added with polymer modified binder. SMA is suffer with severe binder drain down due to the gap graded aggregates mixtures that tends to provide a stable stone to stone skeleton including a rich mixture of asphalt mastic. The Steel Fiber is the additive that will stabilize the asphalt mortar and thicken the bitumen to prevent excessive binder drain down. SMA is good to be used in the presence of fiber to enhance the durability of the SMA mixes. Thus, this paper is presenting the effectiveness of using steel fiber in improving the durability at the surface layer of SMA pavement, which are directly subjected to the traffic effects. To prepare SMA mixtures, Specimens were compacted by applying 50 blows on each face using a Marshall Impact compactor at specific compaction temperatures. Then, the modified specimens were tested to investigate the performance in terms of Los Angeles Abrasion Test, Marshall Stability Test, Resillient Modulus Test and Dynamic Creep. The results indicated that the specimens incorporating steel fiber can be used in binder course of flexible pavement because of its positive stability impact. The result shows that the addition of 0.3% fiber lead to better stability and stiffness while, 0.5% fiber for resilient and enhanced modulus dynamic creep at 25℃ and 0.4% fiber at 40℃. Thus, it can be concluded that the addition of steel fiber in the mixture has the potential to improve binder drain down problem. In order to generate a better pavement mixes in the future, it is advisable to have a further research using the fiber at different compacted temperature and different number of blows.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Pavement is necessary in any country. Pavement can be defined as the most upper surface of the road. Road, runway, street and etc are the best example of the roads pavement that is hard surface. According to other structure in Civil Engineering, pavement is ordinary to be sturdy and durable to withstand the heavy traffic loads. Flexible pavement and rigid pavement are both classified as road pavements (Mohod and Kadam 2016). The rigid pavement is fabricated of Portland cement concrete while the flexible pavement are the mixture of aggregates, bitumen and soil layers. According to (Pereira and Pais 2017), the subgrade, Subbase, base course and the surfacing are the main layers in flexible pavement. Flexible pavement is a mixture of aggregates and bituminous material that is compacted with granular that poured on the top level. In Malaysia flexible pavement are usually used for the roads. Flexible pavement is just like its name "flexible" since the total pavement structure bends and deflects due to its load. In order to accommodate the flexing, It is also normally composed of several layers of materials with flexible surface course. Flexible pavement also plays it function that will distribute imposed loads over the large area of natural soils but smaller area distribution to be compared to rigid pavements.

Hot mixed Asphalt (HMA) is the asphalt aggregate mixture that usually produced at batch mixing facility and must be mixed, spread and laid at an elevated temperature that in range of 140℃ to 160℃ (Kim, Lee et al. 2012). Hot Mixed Asphalt (HMA) is still the process of heating aggregates and asphalt binder.

In general, the asphalt binder is mixed with the aggregate at desired temperature to fully coated aggregate and binder and prepare for suitable for paving. The viscosity will turn out lower at lower temperature and lets the aggregate to be fully coated compared to what is conventionally required in HMA production (Kilas, Vaitkus et al.

2010). These will contribute to the combined weakening of the mastic and weakening of the aggregate-mastic bond.

In order to improve the performance of asphalt mixtures, the using of using fiber is not new in industries. It is continuously being introduced in industries as a new fiber materials such as steel fiber, carbon fiber, cellulose fiber, kenaf fiber, bamboo fiber, etc. Steel fiber were added to enhance the performance of the stone mastic asphalt. According to (Akbulut, Woodside et al. 2000), Fibers such as cellulose, mineral and polyester fibers in the mixture were used to stabilize the mastic asphalt and reduces binder drain down especially for stone mastic asphalt or open graded friction course during the material transportation and paving (Hassan, Al-Oraimi et al. 2005).

1.2 Problem Statement

In this new era technologies, fibers has been used widely in stone mastic asphalt (SMA). Stone Mastic Asphalt was designated to be a hot mixture asphalt with high content of course aggregate, high binder content mortar and fibers additive (Arshad, Masri et al. 2017). According to JKR/SPJ/2008 stone mastic asphalt comprises 65% of course aggregate to meet the requirement before used in Malaysia. The origin purpose of using stone mastic asphalt is that it can improved rutting resistant and resist studded tyre wear(Mahrez and Karim 2010). Besides that, factors such as heavy traffic loads tends to effect the performance of SMA because SMA always shown to give better resistance to plastic deformation and good low temperature properties. SMA is categorized by gap-graded in term of aggregate gradation and high content of course aggregate. Thus, the asphalt concrete facing a binder drain down problem due to its aggregate gradation that caused by the high content of course aggregate (Ahmedzade and Sengoz 2009). A common method to solve this problem was by modifying the asphalt mixtures by adding Steel Fiber. Since Steel Fiber was an additives that tends to stabilize improvement of the properties for civil engineering materials, this study intends to promote Steel Fiber as an additive in asphalt mixture in order stabilize the asphalt mixture and reducing the binder drain down. Thus, the mixtures ensure the homogeneity of the asphalt mixture.

1.3 Objectives

The aim of this study is to enhance the performance of Stone Mastic Asphalt (SMA) with the existence of Steel Fiber. Among the objectives are:

a) To determine the materials properties of PEN (60-70) of asphalt binder and aggregate SMA20.

b) To determine the optimum Steel Fiber content for Stone Mastic Asphalt 20 by evaluating the performance test.

c) To evaluate the mechanical performance of Stone Mastic Asphalt 20 incorporating Steel Fiber.

1.4 Scope of Study

This study focuses to perform a laboratory study to evaluate the performance of stone mastic asphalt incorporating steel fibers. This research undergoes laboratory testing on the material properties test of asphalt binder and aggregate. First and foremost, for the aggregates, it undergoes sieve analysis test, Los Angeles Abrasion Value Test, Aggregate Impact Value Test, Aggregate Crushing Value Test, Flakiness and Elongation test. The testing for the asphalt binder were the physical properties test such as penetration test at 25°C, softening point test and ductility test. By using the results from the physical properties test, the Penetration Index (PI) and the temperature susceptibility of asphalt binders can be determine using nomograph of PI(SP/pen). Marshall Mix Design test also was done in order to find the value of Optimum Bitumen Content.

50 mixture identical specimens were prepared. The steel fiber will be mix with the virgin bitumen 60/70 penetration grade for the whole specimen preparations. 50

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